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STUDY ON STRENGTH AND DURABILITY PROPERTIES OF STEEL FIBRE REINFORCED SELF COMPACTING CONCRETE

D Navya Sri[1], Riyaz Syed[2]

[1]M.Tech Student, Assistant Professor

Department of Civil Engineering, Vaagdevi College of Engineering

Warangal, Telangana-506005

navyasridanduboina96@gmail.com, riyazsyed7800@gmail.com

ABSTRACT

M20, M30, M40, and M60 are examples of low strength standard grade and high grade concrete, respectively, that are investigated in this research as part of the Steel Fiber Reinforced Self Compacting Concrete (SFRSCC) durability investigations. Steel Fiber Reinforced Self-Compacting Concrete (SFRSCC) mixes were subjected to tests for compressive strength and durability using the Chemical Resistance, Initial Surface Absorption Test (ISAT).

This study made use of coarse aggregate, which had a nominal size of 10 mm. The application of viscosity modifying additives (VMA) helps keep aggregates from settling to the bottom of a container and enhances their suspension characteristics. Using finely powdered materials, such fly ash, further eliminates the potential of segregation. A mixture's flow is enhanced when a superplasticizer is used. The rational mix design approach for self-compacting concrete is used in this inquiry. According to the fundamental requirements for SCC mix design specified by the EFNARC (2005), SCC mixes include a significant quantity of powder (material with a parcel size of 0.125 mm) to maintain the plastic yield and attributes of newly mixed concrete. This project is divided into two halves. Mixing SCC with and without steel fibers is the first stage in making different grades. The compressive strength and other mechanical properties of the different grades were tested. In the second step, the durability characteristics were examined based on the testing results using specimens of 100 mm × 100 mm × 100 mm. Acid attack, acid-durability, and sulphate attack are factors that are studied in the context of durability. Plain SCC and Steel Fiber Reinforced SCC are compared in terms of their sorptivity. Results from several studies demonstrate that self-compacting concrete that is

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reinforcing with steel fibers is superior. Each study and its results are detailed in its own chapter.

INTRODUCTION

When reinforced with hard components, self-compacting concrete may partially fill the formwork and flow under its own weight, provided there are no vibrational movements and the concrete stays homogenous. This technique, which began in Japan as a remedy for issues brought on by uneven vibratory compaction, has now spread all over the world. The good flowability, segregation resistance, and insensitivity to building design and reinforcing bar form or quantity of self-compacting concrete allow it to be used across long distances (Bartos, 2000).

Though Professor Hajime Okamura (1997) had suggested the idea of self-compacting concrete in 1986, it was Professor Ozawa (1989) of Japan's University of Tokyo who created the first prototype of the material in 1988. Concrete constructions served to fortify this material's durability qualities throughout its growth.
No standard mix methodology has been released by the Bureau of Indian Standards (BIS) despite considerable study on formal mix design techniques and self-compactibility testing methods by various groups and people. Major corporations in Japan have been in the forefront of the many studies and SC Chas implementations that have taken place since then. In an effort to create a universally accepted concrete, studies have focused on perfecting self-compactibility testing techniques and rational-mix design methodologies.

AverygoodfinishofSCCcement

Improved formwork safety and a quieter work environment are two outcomes of SCC's goal of minimizing or eliminating vibration-induced compaction. Komaura and Ohuchi, 2003a; RILEMTC174SCC, 2000 state that structural studies for reinforced

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concrete construction are improved by increasing reinforcing amounts, lowering bar diameters, and using thicker formwork; nevertheless, compaction becomes more difficult with these changes. In addition to that, SCC breakthroughs that improve on-site efficiency and effectiveness by decreasing the time and effort required to pour uniform concrete in densely populated locations.

For SCC to operate as intended, several qualities are required. So, SCC should be constructed based on the requirements that are either fresh or hardened. Self-Consolidating Concrete: A Historical Overview 1.3

In reality, self-compacting concrete is little more than a principle, despite its long history. Underwater concreting is only one example of the many unique uses for concrete. Compaction is not required while pouring this concrete, says Bartos (2000). There are certain areas where vibration is impossible. Although early self-compacting concretes still relied on very high cement paste concentrations, super plasticizers were gradually added to concrete mixes as they became available. Specific and meticulously controlled placing procedures were required to avoid segregation because of the mixes' rapid shrinkage and high cement paste content. The overall price tag and the quantity of potential applications are both very hefty.

The Akashi-Kaikyo (Straits) Bridge, the world's longest suspension bridge, is 1,991 meters long and was built using self-compacting concrete. It opened to the public in April 1998 (Fig.1.3). The two anchorages used a total of 2,90,000 m3 of cast concrete. To achieve this goal, a novel method of building was devised, one that makes the most of self-compacting concrete. Following mixing in a neighboring batcher facility, the material was pumped out of the plant. The 200 meters of pipes were spaced three to five meters apart. A total of five-meter-long gate valves were used to pour the concrete into the pipes. To maintain a constant surface level of the cast concrete, these valves are mechanically regulated. The use of self-compacting concrete cut the anchoring construction time in half, from 2.5 to 2 years, according to the final findings.

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Anchorage 4A of Akashi-KaikyoBridge

Osaka Gas completed the casting of their enormous LNG tank in June 1998. The tank's wall was made of self-compacting concrete. Twelve thousand cubic meters of self-compacting concrete were held in the tank. 1. With self-compacting concrete, you may raise a single lot to a higher level, cutting down on the number of lots needed from 14 to 10. The number of concrete workers decreased from 150 to 50.

LITERATUREREVIEW

Okamura (1997) addressed the topic of how the addition of super plasticizers [SP] altered the viscosity and flowability of self-compacting concrete in Section 2.3.1. In order to achieve self-compactability, the experimental results have been used to create an index that represents the effect of SuperPlasticizer on the viscosity and flowability. This index estimates the amount of SuperPlasticizer required for the proper viscosity and flowability of SCC using just one set of results.
Part 2.3.2 of the study by Gao Peiwei et al. (2000)

Cement, aggregates, and water, the traditional ingredients of concrete, have been around for quite some time. The construction industry has lately seen a surge in the use of High Performance Concrete (HPC), a new type of concrete that incorporates aggregates, water, and cement. Mixtures of minerals, chemicals, and viscosity modifying agents (VMA) are necessary for high-performance concrete (HPC). Deducing cement in high-performance concrete is the aim of contemporary concrete. Cement is subtracted for this reason. First, a product's longevity; second, the preservation of limited natural resources; and third, the reduction of the financial and

physical strain on skilled personnel.
Chapter 2.3.3 of Raghu Prasad and colleagues' (2004)

Both the initial and final setting durations are being prolonged by the use of admixtures, as stated by these writers. This is due to the slow pozzolanic response that some chemicals cause. Their research suggests that this delayed setting technique can be helpful for hot weather concrete pours. The strength of mixed cements and concretes will keep increasing even after 28 days. Concrete reinforcement is less likely to corrode because of this.
Part 2.3.4 Lachemi, M., and Hassain, K.M.A. (2004)

The shear behavior of self-compacting concrete (SCC) may be significantly improved with the use of viscosity-modifying agents (VMAs). To find the optimum additives for making SCC blends, we tested four types of polysaccharide-based viscosity modifiers. Research on the unique forms of VMA is encouraging the construction of SCC mixes with fresh and hardened properties that are equal to or even better than those generated using commercially available VMA and Welan gum. At a dosage of 0.05 percent, the suggested new VMA type satisfies both the fresh and hardened features. of SCC standards, resulting in economical SCC mixes using 7% less VMA dosage than commercial VMA.
Part 2.3.5 In 2006, Collepardi, A., Passuelo, M., and Croce, E. N.
The purpose of this study was to find out whether adding VMA could solve the problem of not having enough powder material (maximum size = 75µm) in a volume range of 170-200 liters/m3. The findings showed that the mineral filler was entirely removed. Without mineral filler, an unsegregable SCC may still be achieved by adding a little amount of cement and a large amount of VMA (say, 2 to 7 Kg/m3). Finally, chemical and mineral admixtures are crucial for maintaining the fresh and toughened features and improving the durability qualities of SCC.
Significant Advances in Self-Consolidating Concrete 2.4.1.1 In his 1993 paper, Kuroiwa

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EXPERIMENTAL INVESTIGATIONS ON SELF COMPACTINGCONCRETE

GENERAL

Tests on M20, M30, M40, and M60 steel fiber reinforced self-compacting concrete's impact on durability are examined in this chapter. The concrete used was of moderate strength and was either standard grade or high grade. In this experimental study, several types of self-compacting concrete reinforced with steel fibers were tested for their fresh and hardened qualities. After the 100 mm x 100 mm x 100 mm cubes were cast, studies were carried out to determine the long-term durability of plain SCC and SCC reinforced with glass fiber. We conducted the following research as part of our experimental program:

1. To understand the new and old characteristics of plain SCC via varying degrees of cultivation.
2. To understand about the fresh and hardened characteristics of Steel Fiber Reinforced SCC and to manufacture a variety of grades.
3. Collect information on the durability of plain and steel fiber reinforced SCC with respect to time, across various M20, M30, M40, and M60 classes.

3.1.1 Things Required Section 3.1.1 of concrete.

Cement, when mixed with water to make a paste, may be poured or shaped into a solid that will then solidify. A variety of organic compounds that are used as adhesives are referred to as "cement," but the phrase "cementalone" really denotes a building material.

This experiment used Ordinary Portland Cement, Grade 53, which is readily accessible at the local market. We tested a number of attributes in accordance with IS:4031-1988 to back up IS:12269-1987.

Acid Attacking Factor = Acid Loss After Immersion, Transverse to Diameter
The pH diagonal is one hundred percent before submersion.
As the AAF value increases, the dimensional stability deteriorates.
When cubes are immersed in various acid types and concentrations, the percentage loss of specimen weight is used to estimate AWLF, which is a function of immersion time. The acid weight loss factor is the specimen weight loss following immersion.
The sample's mass before immersion, multiplied by once
A larger AWLF number results in a larger weight loss.
Combining these components, ASLF×AAFÏAWLF, yields a single factor that

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represents durability; this factor is referred to as the ADLF. evaluate solid tumors and squamous cell carcinomas in solid fat for sulphate attack To evaluate the impact of sulfate attack on concrete and its resilience to the attack, concrete cube specimens were submerged in a solution containing 5% sodium sulfate in a controlled environment (figure 3.4.1). 2. The effects of the chemical attack have been assessed by taking the mass change into account. Cubes of 100mm × 100mm × 100mm were gradually immersed in a sodium sulfate solution with a concentration of 5%. The effects of sulfate attack on the performance and properties of concrete are discovered. The sulfate attack resistance of concrete has been assessed by taking into account changes to its dynamic modules of elasticity. Even with a quick inspection, the sulfate attack on cracking and disintegration is evident. d.

ImmersionofSpecimensinAcidsandSulphate

TestsforSorptivity

The sorptivity of unsaturated concrete samples is defined as their capacity to absorb water. Sorbitivity is a significant measure of concrete quality. One way to measure the potential permeation of water and other potentially dangerous substances into concrete is by measuring its sorptivity. Cube specimens of 100mm × 100mm × 100mm were subjected to sorbtivity testing for SCC and SFRSCC according to Hall's method (Hall, 1989). Removal from the tank and subsequent drying occurred after specimens had cured for 28 days. The initial mass of the cubes was noted after they had dried. A cube was then filled with water until it was 10 mm below the specimens' bases. The cube draws water up from the bottom and sends it floating upwards by capillary action. After curing had concluded, specimens were evaluated at certain intervals (28 days) at 1, 5, 10, 15, 30, 1, 2, 3, 4, 5, 6, 24, 48, and 72 hours. Sorptivity tests were conducted continuously for three days

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after the required curing period.
The coefficients or sorptivity coefficients were obtained from the equation.

1. $S = i/t^{1/2}, i = \Delta W / Ad$

Here is a simplified version of the equation given above: ΔW is the SI unit for the amount of water absorbed, measured in kilograms. The square meter area of the specimen that was submerged in water is denoted by A, the density of the medium was given by d (which was 1, as water was used as the medium), and the duration was measured in minutes. Second half, kilograms per square meter is the unit of mass. We made a graph showing how i changed in relation to 1/2.

TestingofSCCPandSFRSCCSpecimensfor Sorptivity

RESULTSOFTHEEXPERIMENTAL INVESTIGATIONS ON SCC and SFR SCC

This chapter discusses the results of tests conducted at different stages.
The Attributes of Materials 4.1
For a complete inventory of the material properties used to create SCC and FRSCC, refer to the tables. From section 4.1.1 to section 4.1.6.

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Table4.1.1 PhysicalpropertiesofOrdinaryPortlandCement

S.No	Property	TestMethod	TestResults	Requirements as perIS:12269–1987
1.	NormalConsistency	VicatApparatus(IS:4031Part -4)	32%	26%-33%
2.	Specificgravity	SpecificGravitybottle(IS:4031Part-4)	3.1	3.15
3.	Initialsettingtime	VicatApparatus(IS:4031Part -4)	45min	Notlessthan30minutes
	Finalsettingtime		580min	Notmorethan10 hours
4.	Fineness	Sieve test on sieveno.9(IS:4031Part–1)	2.37%	10%
5.	Soundness	Le-Chatliermethod(IS :4031Part–3)	4mm	Notmorethan10mm

PropertiesofAggregates

S.No	ISSieveSize	Weight Retained gm	Cumulative WeightRetainedGm	Cumulative % Weight Retained	Cumulative % Passing	Grading LimitsIS:383-1970 Zone II(%)
1	10mm	0	0	0	100	100
2	4.75mm	10	10	1	99	90-100
3	2.36mm	80	90	9	91	75-100
4	1.18mm	120	210	21	79	55-90
5	600microns	400	610	61	39	35-59
6	300microns	300	910	91	9	8-30
7	150microns	70	980	100	1	0-10
8	<150microns	20	1000			
9	**Total**	**1000**		283		

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Table4.1.2.2SieveAnalysisofCoarse Aggregate

S.No	IS Sieve Size	WeightRetainedgm	Cumulative WeightRetainedgm	Cumulative % Weight Retained	Cumulative % Passing	Grading LimitsIS:383-1970 ZoneII(%)
1	20mm	0	0	0	100	100%
2	12.5mm	400	400	8	92	90-100%
3	10mm	2300	2700	54	46	40-85%
4	4.75mm	2200	4900	98	2	0-10%
5	2.36mm	100	5000	100	0	
6	1.18mm	0	5000	100	0	
7	0.6mm	0	5000	100	0	
8	0.3mm	0	5000	100	0	
9	0.15mm	0	5000	100	0	
10	**Total**	**5000**		660		

Coarseaggregate belongsto10mmGraded aggregate

FinenessModulus=CumulativePercentageweightretained/100

=660/100 =6.6

Table4.1.2.3PropertiesofFineandCoarseAggregate

S.No	Property	FineAggregate	Coarse Aggregate
1	Specificgravity	2.59	2.64
2	LooseDensity	1530Kg/m^3	1453Kg/m^3
3	RoddedDensity	1640Kg/m^3	1526Kg/m^3

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4.1.3 PropertiesofFlyAsh(DirkIndiaPrivateLimited)

(Source:AsubsidiaryofAmbujaCementsLtd.,Mumbai.)

Table 4.1.3.1PhysicalpropertiesofFlyash

S.No	Characteristics	Properties
1	Specificgravity	2.3
2	Specificsurfacearea	420 m^2/kg

Table 4.1.3.2ChemicalcompositionofFlyash

S.No	Characteristics	Percentage contents	Percentage IS3812-2003
1	Silica, SiO_2	68	Minimum35
2	Alumina,Al_2O_3	23	16-28
3	Ironoxide,Fe_2O_3	4	4-10
4	Lime,CaO	1.1	0.7-3.6
5	Magnesia,MgO	0.5	Maximum5
6	SulpharTrioxide, SO_3	0.03	Maximum3
7	Loss onIgnition	0.3	Maximum5

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CONCLUSIONS

A variety of SCC and SFRSCC mix grades have had their durability characteristics studied experimentally.
This experimental inquiry yielded the following results:
1. Fiber reinforced self-compacting concrete might be made more effective by using self-lubricating fibers in the mixture. Preserving the original characteristics of self-compacting concrete requires careful dosing of superplasticizer and viscosity modifying agent.
Second, the optimal length for fibers is 12 mm, and the optimal aspect ratio is 30, so they work better.
3. The optimal dosage of steel fibers for one cubic meter of concrete, after correcting for additive dosage, is 31 kilogrammes.
There are several different concrete grades to choose from, including M20, M30, M40, and M60. Adding steel fibers to self-compacting concrete increased its compressive strength by 2 to 10 percent. When contrasted with regular self-compacting concrete.
5. The workability decreases as the fiber content increases. Adding superplastizers and VMA to concrete might improve its workability and flow properties.
6. As the concrete grade increased, the absorption of Steel Fiber Reinforced SCC decreased.
The rate of water absorption per unit area in SFRSCC reduces with increasing concrete grade.
As the time spent in an acidic environment was increased, so was the amount of ASLF. Likewise, neither SCCP nor SFRSCC were spared. When measured on the same concrete grade, the percentage of strength loss for SCCP and SFRSCC were almost identical.
9. As the duration of immersion in a solution containing 5% acids, such as Na_2SO_4, HCl, and H_2SO_4, increased, the concrete in the corners of the standard cube experienced worse damage. On the other hand, SFRSCC had superior endurance as it exhibited less disruption compared to SCCP.

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